DOCUMENT RESUME

ED 472 320 SE 067 112

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TITLE	Mentoring and Coaching for Teachers of Science: Enhancing Professional Culture.
PUB DATE	2003-00-00
NOTE	15p.; In: Science Teacher Retention: Mentoring and Renewal. Issues in Science Education; see SE 066 056.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS	*Program Development; *Beginning Teachers; Culture; High Schools; *Mentors; *Professional Development; *Science Education

ABSTRACT

Mentor programs provide an opportunity to foster a professional culture that focuses on improving the teaching, learning, and assessing of science as well as a means to retain highly qualified new and experienced teachers. This paper outlines key strategies, structures, policies, and practices that contribute to developing and sustaining quality mentor programs; describes different models (mentoring one-on- one, study groups/team mentoring, mentor teacher-leader model, and collaborative mentor networks); and offers a snapshot of one program that exemplifies each model. (Author)

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Mentoring and Coaching for Teachers of Science: Enhancing Professional Culture

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Anne Newton is the lead author of *Mentoring: A Resource and Training Guide for Educators* (Regional Laboratory for Educational Improvement 1994). She has been a classroom teacher, reading specialist, staff developer, and mentor. Currently, she is a program director at Jobs for the Future in Boston, Massachusetts.

By the year 2007, over 2 million new teachers will be needed in our nation's schools (National Center for Education Statistics [NCES] 2002; National Commission on Teaching and America's Future [NCTAF] 1996). Currently, one of the critical teacher shortage areas is in science. In the face of that reality, over 20 percent of high school science teachers lack a minor in their main teaching field. Additionally, 56 percent of high school students taking physical science are taught by out-of-field teachers (National Commission on Mathematics and Science Teaching for the 21st Century 2000). This shortage of qualified science teachers amidst high demand is magnified by continued high rates of teacher attrition. Thirty to fifty percent of new teachers leave the profession during their first few years of service, with the highest attrition rates occurring in urban settings (NCTAF 1996). In spite of this crisis, there is good news. Mentoring and induction programs can and do make a difference in significantly reducing teacher attrition. The challenge, however, is twofold and framed by two key questions: How can we improve mentoring and induction programs for science teachers? What specific strategies for recruitment, preparation, and licensure will enhance the qualifications of science teachers in our nation's schools? This chapter does not explore the second question; however, it is an imperative for increasing the quality and the number of science teachers K–12. Responding to the first question, this chapter suggests key strategies, structures, policies, and practices that will contribute to quality mentoring and induction for our teachers of science.

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Developing a Mentor Program for Science Teachers

Mentor programs for science teachers help to improve the teaching, learning, and assessing of science. Mentor programs enable teachers to (1) increase their knowledge of content, (2) improve their understanding of how to embed scientific inquiry into teaching, (3) increase their instructional competence by reflecting on and analyzing the impact of teaching practices on their students' learning, (4) share in a school's norms of collegiality and experimentation, and (5) enhance their ability to deal effectively with diversity (diverse groups of individuals, different learning styles, and various teaching styles). In turn, effective mentor programs offer a way to assist districts to retain highly qualified new and experienced teachers.

Keys to Effective Program Design and Sustainability

Designing and sustaining an effective mentor program depends on several conditions. The following key factors can mean the difference between a successful program and one that does not achieve desired results:

- *Key inputs (knowledge base, context, and critical issues) are essential to effective program design.* It is critical to gather and analyze data related to these inputs prior to or while designing a program. The knowledge base consists of research on teaching, learning, and assessing; the nature of the academic discipline; and knowledge of mentoring and professional development. The context includes information on the participants (e.g., who they are, what their needs are) and the history of mentoring and professional development in the district. Critical issues encompass equity, diversity, and time.
- *Supports and challenges in the system need to be considered before implementing a new program.*
  - Will the district's professional culture support a mentor program? For example, will administrators articulate the importance of mentoring? Will they nurture and support a learning community in their schools?
  - Are there policies, procedures, and schedules in place that will support the program, or is the climate conducive to these changes? For example, does the current schedule provide time for teachers to meet during the day? Will administrators allocate or reallocate time to enable mentors and new teachers to observe each other and work together to nurture their own development?
  - How will the mentor program for science teachers fit into the district's professional development system or with its current mentor program?
- *Continuous assessment maintains program integrity and aids in sustaining the program.* The intended results are most likely to be achieved if continuous assessment of a program's effectiveness—including its impact on students' learning and teachers' teaching, learning, and assessing practices—is ensured. Without assessment, the context can change, and the program can be unresponsive to those adjustments. Continuous assessment also provides data to aid in sustaining a program.

- *The building of a professional culture in a school or district matters.* Collaborative planning by a multi-representative planning group lays the groundwork for empowerment, ownership, shared leadership, and sustainability of the mentor program.

Designing a Mentor Program

Designing a program includes a series of critical tasks: establishing a diverse, multi-representative planning group, developing the program and the policies and procedures to maintain it, ensuring a supportive environment within the district, preparing and supporting mentors, supporting new teachers, and evaluating the mentor program. Each of these is briefly discussed below.

Establishing a Diverse, Multi-Representative Planning Group

To lay the groundwork for a collaborative design process, a diverse, multi-representative planning group needs to be established and charged with designing and evaluating the program. Its membership may consist of science teachers (potential mentors and second-year teachers); administrators, both central office and school-based; representatives of the teachers' association; school board members; parents and/or community members; and faculty from colleges and universities that prepare teachers (if geographically possible).

The importance of this group cannot be overstated. Without the support of those who affect or are affected by the program, it may fall short of its intended outcomes or even fail. Comprehensive representation also offers the potential of broad support when budgets need to be trimmed.

Developing the Program

The planning group needs to design a program that fits the needs of its specific population of teachers and students, that fully uses resources (people, practices, and funds) available within the district or community, and that accommodates organizational constraints. Several variables can influence the program's design, such as the number, background, and skills of new science teachers; the number, interest, and competence of potential mentors; the extent to which a district's norms and expectations encourage collegiality and experimentation; administrative support; current supervision and evaluation procedures; quality of functioning professional development programs; and available financial resources.

Thus, the multi-representative planning group may undertake a series of tasks as it designs the program. Among these are the following: reviewing current research and best practice; joining a professional organization's chat room or listserv; identifying the program's philosophy, mission, and goals; determining how the program for science teachers can be incorporated into the district's mentor program (if appropriate); defining roles and responsibilities of participants in the program; determining the criteria and procedures for selecting mentors and assigning them to new

teachers; assessing the needs of new teachers and mentors in the district; providing options for finding time for mentors and new teachers to meet; determining the content and design of mentor training; developing a proposed budget; presenting a proposal to the school board; providing for the evaluation of the program; establishing a plan for piloting the program; and overseeing the implementation of the program.

Much emphasis is placed on the relationship between a mentor and a new teacher, but the success of a mentor program depends on many people and institutions. All of these critical players have particular roles and responsibilities to fulfill, as displayed in Table 1. The planning group has the responsibility of identifying and communicating these roles and responsibilities to key players.

Developing Policies and Procedures

Prior to implementation, the collaborative planning group should develop, articulate, and record policies and procedures for different aspects of the program—for example, selection criteria for mentors and processes for selecting mentors, matching mentors and new teachers, and reassigning pairs. In establishing selection criteria for mentors, it might be helpful to review the qualities of mentors offered by the literature (Odell 1989; Ohio Department of Education 1990; Oregon Department of Education 1990; Zimpher and Rieger 1988). In choosing those that are relevant, the planning group needs to apply its knowledge of the local district and the purpose of the district's program. In selecting mentors, the planning group can assess an applicant's qualities in several ways: through application forms, interviews, letters of recommendation, informal conversations, records of continuing professional development, observations, or videotapes.

Experience has shown that several factors should be taken into account when assigning mentors to new teachers and that procedures must be in place to enable reassignments when necessary. There is general agreement that it is important to assign mentors to new teachers who teach the same subject and grade level and have ready access to each other (e.g., in adjoining classrooms, on the same floor, in the same building). In addition, it has been found that mentoring relationships form best when teaching style and ideology mesh.

These conditions are ideal, of course, and cannot always be met. Occasionally, mentoring relationships will not work. Procedures need to be in place that enable the mentor or the new teacher to express his or her concerns to a third party for resolution. Some districts have discovered that training a "pool" of mentors each year allows them flexibility to reassign mentors to new teachers when a relationship falters or to match a mentor to a new teacher who is hired in the middle of the school year. A mentoring relationship that does not work need not be seen as failure, but rather as a difference in style.

Table 1. Roles and Responsibilities of Participants in a Mentor Program

Mentor	New Teacher	Administrators	Other Faculty	School Board	Teacher-Preparation Institutions	State Education Agency
Orients new teachers to school, district, and community Links new teachers to resources Provides continuing systematic support to new teachers Enables new teachers to increase their knowledge of the content and process for embedding scientific inquiry into teaching Enables new teachers to analyze their teaching practice in terms of its impact on student learning Facilitates or assists in professional development of new teachers Attends all mentor training programs	Plans, teaches, facilitates, and evaluates progress of students in own classroom Attains higher instructional competence by reflecting on and analyzing the impact of teaching practices on students' learning Enhances ability to deal effectively with diversity in students, learning styles, and teaching styles Participates in needs assessments Develops own professional development plan for year Meets and conferences with mentor (or mentoring team) on a regular basis	Supervise and evaluate new teachers (building) Facilitate faculty and community awareness and support for mentor program (e.g., personnel, resources, programs, and organizational structure) (building, district) Serve on planning group and on mentor selection committee (B, D) Participate in orientation and training sessions (B, D) Develop schedules for release time or common planning, observation, or conferencing time (B) Recognize and plan for changes in interpersonal and interorganizational relationships (B, D)	Serve on planning group Serve on mentor selection committee Support mentor program Assist in creating a supportive teaching environment in the school, encourage collegiality Provide direct assistance to new teachers as arranged through mentors Participate in evaluation of mentor program	Establishes policy to make mentoring of new teachers one of the district's priorities Ensures support for mentor program (e.g., personnel, resources, programs) Establishes planning group Serves on planning group Approves a district position, full- or part-time, to coordinate a mentor program Reviews evaluation of mentor program	Focus on content and reflection on practice in preservice training Serve as member of multi-representative planning group, if proximity permits Contract with district to provide training to mentors, new teachers, and/or administrators; evaluate the program; facilitate group seminars for mentors and new teachers; or coordinate action research Serve as member of a mentor team for new teachers Function as substitute to release new teacher for conferencing, planning, professional development, or cross-visitations	Works with interested parties to establish program guidelines Provides technical assistance to local districts Coordinates and establishes communication networks among districts Shares information with and links districts to resources Conducts regional meetings for mentors and new teachers Consults with colleagues in state education agencies in the region

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Table 1. Roles and Responsibilities of Participants in a Mentor Program (continued)

Mentor	New Teacher	Administrators
Models continual professional development and assists new teachers in designing their own professional development plans	Participates in variety of professional development activities (e.g., training activities for new teachers, cross-visitations with mentors and other faculty)	Meet with mentors and new teachers at least two to three times per year (B, D)
Participates in evaluation of mentor program	Participates in evaluation of mentor program	Coordinate programs throughout the district (D)
Assists in revision of program for next year	Assists in revision of mentor program for next year	Provide professional development activities for program participants (D)
		Ensure and participate in program evaluation as well as revision (B)
		Establish collaborative relationships with local colleges and universities

Source: Newton, A., K Bergstrom, N. Brennan, C. Gilbert, N. Ibarguen, M. Perez-Selles, and E. Thomas. 1994. *Mentoring: A Resource and Training Guide for Educators*. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

Ensuring a Supportive Environment within the District

The most difficult task of implementing a mentor program is scheduling time for mentors to meet informally or for observations and conferences. Teachers or administrators who are involved in mentor programs offer the following solutions:

- release mentors and new teachers from noninstructional duties;
- schedule common preparation times once or twice a week for mentors and new teachers to discuss issues of concern to the new teachers;
- arrange for mentors and new teachers to share a common break time or lunch period for informal interaction;
- employ a roving substitute one or two days each month;
- use volunteer substitute teachers, employ retired teachers, or use visiting teachers (e.g., experts from museums or industry who come to teach a class);
- have veteran teachers present a lesson to two classes; and/or
- provide opportunities for team teaching, demonstration lessons, and observations that benefit students in both teachers' classrooms.

Preparing and Supporting Mentors

Preparation and follow-up support offered to mentors are critical elements of a mentor program. Thrust into this new role, mentors will question their skills, the processes they use, and their impact on new teachers throughout the mentoring experience. Answers provided through training and networking with other mentors, colleagues, administrators, and faculty from teacher preparation programs will allay fears and strengthen programs.

The skills and knowledge needed to begin the mentoring process are often provided during a two- to five-day summer institute for mentors. During the school year, follow-up support in the form of regularly scheduled study groups, seminars, or sharing sessions offers opportunities for new mentors to address the issues they are facing.

The preparation and ongoing support of mentors should address the following:

- the roles, responsibilities, and expectations of being a mentor;
- the goals of the program;
- the concerns and needs of beginning teachers;
- the impact of cultural differences among teachers, students, and parents;
- adult development;
- the change process;
- coaching and mentoring skills (communication, observation, and conferencing);
- effective teaching, learning, and assessment practices (e.g., content expertise in science, reflection on the influence of teachers' behavior on students, different assessment strategies, how to co-plan and co-teach a lesson); and
- curriculum development strategies and resources.

It is critically important to give teachers time to use and reflect on the knowledge and expertise they are gaining. They can practice techniques among themselves or with new teachers, reflect on the impact of these strategies, and be an integral part of the continuous improvement of the program.

Supporting New Teachers

The relationship a new teacher has with a mentor enables her or him to try new instructional strategies, interact with parents, or co-design a new lesson with a trusted colleague. Targeted professional development opportunities can complement this mentoring relationship. These might include the following: (1) a formal, facilitated meeting with other new teachers on a monthly basis to discuss what they are learning about teaching and learning; (2) a new teacher's attendance at a professional conference with his or her mentor, time to process what they have learned together, and an opportunity to share their learning with the faculty; and (3) the co-development and implementation of lessons and units with follow-up reflection on what was done, why, and with what impact on students. All of these experiences assist new teachers on their journey to becoming exceptional teachers.

Evaluating the Mentor Program

Any new intervention requires ongoing evaluation of its effectiveness. A mentor program may be assessed through surveys, interviews, and quantitative data on new teachers' attendance, involvement in school and professional activities, and retention over time. Provisions for an evaluation should be established early in the design by the multi-representative planning group or an evaluation team it appoints. Decisions need to be made about the focus of the evaluation, what baseline data will be gathered, how the evaluation will be conducted, when, and by whom. As the program is being developed, a rubric can be used to assess the relative effectiveness and focus of the development process itself. What are the key pieces of infrastructure of effective programs? Is improved instructional practice a goal? What student outcomes can be anticipated? (See Table 2.) Long-term evaluation of the program's effectiveness should address the following:

- effectiveness of the program in meeting its organizational and individual goals;
- changes in new teachers' ability to process classroom experience and modify their behavior;
- benefits and challenges identified by mentors and new teachers;
- new teachers' perceptions of their mentor's impact on them;
- mentors' views of their new teachers' impact on them;
- new teachers' impact on their own classes, staff members, and parents;
- the program's impact on students by race and ethnicity;
- the program's impact on the entire school;
- retention of new teachers and mentors; and

Table 2: Developing an Effective Mentor Program

Task: To design and implement a mentor program in which experienced teachers serve as new teachers' mentors for one year.

Criteria for Success	1 Unacceptable	2 Basic	3 Proficient	4 Exemplary
Involvement of Key Stakeholders	Mentor program is designed and planned by a few individuals. Could be "top down" or "bottom up."	Teachers and administrators work together to design the mentor program.	Teachers and administrators representing all grade levels, school committee members, parents, and students are involved in designing and planning the mentor program.	There is a multi-representative design team that continually assesses the program, identifies what is working and not working, and makes changes along the way.
Selection Criteria and Process for Mentor Teachers	No criteria exist. Building principal "hand picks" the mentor teachers.	Mentors volunteer and are selected by a mentor program committee. No criteria exist.	Criteria for selecting mentor teachers are identified, and a mentor program committee selects mentors with input from the building principal.	Potential mentors complete an application, which includes recommendations from colleagues.
Mentor and New Teacher Matches	Mentors and new teachers are matched without consideration of grade level, content area, or geographic location.	Mentors and new teachers are matched (to the degree possible) according to grade level and content area.	Building principals contribute to the matching process by considering the compatibility of individual styles of the mentors and new teachers.	A procedure exists whereby, in the event of unworkable matches, both parties are "held harmless" and a new match is made.
Training and Support	Training consists of disseminating and "walking through" the new teacher handbook.	An orientation session is held for mentors outlining roles and responsibilities.	Three to four days of mentor training is provided to all mentor teachers. Training includes qualities of effective mentors, needs of new teachers, active listening and questioning skills, cognitive coaching, and data collection techniques.	Mentor and new teacher pairs are provided with on-site coaching and support throughout the year.

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Table 2. Continued

Criteria for Success	1 Unacceptable	2 Basic	3 Proficient	4 Exemplary
Supporting Policies and Procedures	There are no policies in place to support the mentor program. However, the district has decided to implement a mentor program.	A set of guidelines is developed to support the mentor program. Incentives are provided for mentor teachers. Training dates are set. Mentors and new teachers have to "catch as catch can" to find time to meet.	Structures are in place to provide mentors and new teachers with time during the day to meet and visit each other's classroom.	The school schedule provides regular professional development time during the school day for all teachers allowing new teachers to link with and learn from other colleagues.
Mentor Program Evaluation	There is no evaluation of the mentor program.	Evaluation of the mentor program focuses only on participant satisfaction and enjoyment.	The impact of mentor training on supporting mentors to successfully fill their roles is evaluated. A survey of new teachers' needs is conducted and used to evaluate how well the mentor program serves those needs.	Mentor teachers do a self-assessment around their performance as a mentor teacher. New teachers conduct a self-assessment of their teaching against clearly defined teaching competencies. Quantitative data are collected and analyzed on the new teachers' and mentors' involvement in school, district, and professional activities and their retention. A rubric identifying criteria for success of a mentor program is developed and used to assess its efficacy.

Source: Learning Innovations, a division of WestEd, 91 Montvale Avenue, Stoneham, MA 02180.

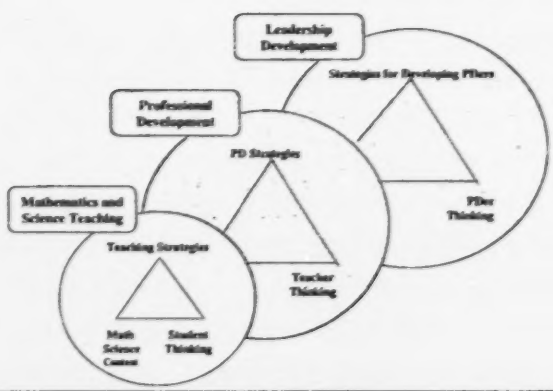
- involvement of new teachers and mentors in school and professional activities.

The collaborative planning group or the evaluation team should obtain, in a structured manner, feedback on these concerns from any individual who has been involved in the program. These data should be analyzed and shared with program planners and participants to revise the program prior to the next year's implementation.

Mentoring Teachers of Science: A Learner-Centered Construct

Regardless of the model of mentoring and induction, a learner-centered approach is essential. Deborah Ball's (1999) framework describes the relationship among student learning, teacher learning, and professional developer or leader learning. Figure 1 illustrates the intersecting content of math and science content, student thinking, and teaching strategies. That intersect becomes the content anchor for mathematics and science teaching. That anchor in turn intersects with teacher thinking and professional development strategies. The combining intersect becomes the content anchor for leadership development, which intersects with professional developer thinking and strategies for developing professional developers.

Figure 1. Circles of Learning



Source: Adapted from D. Ball. 1999. Presentation to the National Commission on Mathematics and Science Teaching for the 21st Century, Washington, DC.

Models of Mentoring: Moving beyond the One-on-One Approach

Historically, the primary model of mentoring has taken the form of a one-on-one approach. An experienced science teacher, for example, is selected and trained to serve as a mentor for a new science educator. During the first year of the new teacher's

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career, the mentor assists with the "nuts and bolts," providing classroom coaching and observation to support the new teacher in reflecting on his or her practice. This approach is powerful and focused, encouraging relationships and therefore reducing isolation, one of the top reasons new teachers leave the profession. (See the "Belmont, Massachusetts" text box.)

With a significant increase in the number of new teachers in our schools, however, the one-on-one model is not possible, particularly in larger schools. Lessons learned from several countries, including the United States, point to the need to expand the concept of mentoring and coaching (Britton et al. 2001). Other professional development strategies, such as the ones discussed below, can be effective in the right context, with the right processes, and given the required resources.

Belmont, Massachusetts
Liz Sorrell, K–12 science coordinator for the Belmont, Massachusetts, school district, serves as a mentor and coach to science teachers in her district. While she has a supervisory responsibility, the one-on-one strategy of mentoring a new teacher includes a content-based approach that includes planning conferences, classroom observation and data gathering, and reflective conferences.

A videotape of this process is part of the video library *Teachers as Learners: Professional Development for Science and Mathematics*, available through Learning Innovations at WestEd. *www.wested.org/li*

Study Groups/Team Mentoring

The value of study groups includes collegial interaction, teacher-selected areas of study, and the benefit of expert content knowledge on the part of the facilitator. Teachers participating in study groups often examine student work and reasoning, as well as curriculum and assessment. The focus on the teacher's actual work and the culture of collaboration are among the greatest benefits of this strategy. (See "Lansing, Michigan" text box.)

Lansing, Michigan
Deb Smith, former professor at Michigan State University and now science teacher coordinator in the Lansing Public Schools, has designed and led several teacher study groups for science educators. Some of the implementation requirements for study groups include: time for teacher groups to meet; support from administrators; substantive topics to study and discuss; study group processes that allow for a variety of activities and access to human, electronic, and print resources; self-direction and self-governance on the part of the teachers; opportunities to enhance group interaction skills; and a facilitator with deep content knowledge.

For more information contact Deborah Smith, Lansing Public Schools *www.lsd.k12.mi.us*

Mentor Teacher-Leader Model

Teacher leadership is often cited as a key aspect of school improvement and school reform. That said, all too often teachers are not afforded opportunities to assume leadership roles (unless they take on formal administrative roles). There are several examples of how well-designed teacher leadership programs can support science teachers who are leaders in their fields. The National Institute of Science Leadership Academy, now in its fourth year, supports professional developers in enhancing their leadership skills by providing professional development for science and mathematics teachers in their home states. Maine's A.A.R.B.E.C. program focuses on developing

teachers as leaders and professional developers. (See the A.A.R.B.E.C. text box.)

Collaborative Mentor Networks

Collaborative networks not only have an impact on local implementation of quality mentor programs, they also enhance the ability of the members of the network to collaborate. Collaborative networks are distinct from other networks in some fundamental ways. First, shared leadership among the coordinators and the network members tends to be the norm. Second, collaborative networks tap into the wisdom of experience and practice of their members and work to enhance the knowledge and skills of the members. Finally, collaborative networks often reinvent themselves and become a force of greater service than was the initial intent. (See the N.N.E.C.N. text box.)

In Conclusion

The need for qualified science teachers has never been greater. Mentoring programs that specifically respond to their preparation are necessary for retaining the teachers of science who will best serve our youth.

Advancing the Agenda for Results-Based Certification in Maine (A.A.R.B.E.C. Maine)

The Maine Department of Education is spearheading the A.A.R.B.E.C. project, the centerpiece of which is a regional mentor teacher leader model primarily supporting new teachers of science and mathematics. Eight teachers (each serving one of eight regions) are released from their regular teaching duties to serve as a regional mentor teacher leader for the school year. The primary role of these teacher leaders is to provide professional development and site-based support to schools and districts within their respective regions around the development and implementation of effective mentor and induction programs. Some of the essential elements for implementing this model include release time for teacher leaders, professional development for teacher leaders, administrative support, and resources (financial, time, and materials) for regional teacher leaders and local mentors.

For more information contact Judith Cox, Maine Department of Education *www.state.me.us/education*

The Northern New England Co-Mentoring Network (N.N.E.C.N.)

Under the leadership of Page Keeley of the Maine Mathematics and Science Alliance, the National Science Foundation–funded N.N.E.C.N. project will provide trained mentor teachers to work with new science and mathematics teachers who are seeking traditional and alternative certification in the northern New England states. This collaborative network will provide for tri-state professional learning opportunities and mentor training, sharing of key learnings and challenges within each state, and an overall evaluation of program impacts.

For more information contact Page Keeley, The Maine Mathematics and Science Alliance *www.mmsa.org*

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